

The Final Piece to a Complete Science of Behavior Behavior Development and Behavioral Cusps

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In order to understand the complex behavior of an individual, what that individual has learned must be understood. Unfortunately, behavior analysis and psychology in general have not studied the cumulative effects of the learning principles. However, there are concepts in behavior analysis that, although not well researched, address this area. These concepts are basic behavioral repertoires, cumulative hierarchical learning, behavioral cusps, generative instruction, and pivotal areas of functioning. The importance of these concepts for assessment, the selection of target behaviors, and curriculum design is described.

Keywords: behavior development; behavioral repertoires; cumulative hierarchical learning; behavioral cusps, generative instruction

Michael's 1993 text, *Concepts and Principles of Behavior Analysis*, contains an outline of the science of behavior that is organized from the viewpoint of considering everything "we need to know in order to predict, control, or interpret the behavior of an organism." (p.1) The logically organized categories allow one to see the substantial progress and knowledge base that has been achieved and also what areas need further research. The outline is broken into the following five broad categories:

1. **Stimulus:** we need to know "what stimuli can affect the organism" (p. 1)
2. **Response:** "we have to know how that organism can affect the environment" (p.1)
3. **Unlearned behavior:** "It is also important to know what environment-behavior relations make up the organism's unlearned or *built-in repertoire*" (p. 1) This section describes unlearned reflexes and more complex types of unlearned behavior, such as fixed action patterns.
4. **Learning and Motivation:** "one must understand how the organism is modified by its interaction with the environment, how new environment-behavior relations are learned or unlearned" (p. 1) Habituation, respondent functional relations, and operant functional relations make up this category.
5. **What a specific organism learns:** "to understand any particular organism one must know not only those functional relations that are common to all members of that species, its unlearned repertoires and how it learns, but also what it has learned." (p. 1)

Physiological psychologists and psychophysicists dominate research in the first two areas. Much is understood about human receptors and effectors. For humans, research in the third area has identified many human reflexes but more complex forms of unlearned behavior have been more difficult to prove. Michael points out that the fourth area has been the major area of study within behavior analysis. The study of reinforcement, punishment, extinction, stimulus discrimination, stimulus generalization, schedules of reinforcement, and many others all fall within this category. Decades of research have demonstrated the importance of these principles for understanding, predicting, and controlling human behavior.

Michael says, “[The] fifth category has not been a major focus of interest for behavior analysts...” (p. 1) Michael argues for the importance of this fifth category by saying:

An understanding of the principles of learning and motivation, no matter how complete, will tell us little about the significant personal differences that are of such practical importance. We are all susceptible to respondent and operant conditioning, but to understand individual differences it is further necessary to know for each of us what stimuli have become conditioned stimuli, what behaviors have been increased in frequency by what kinds of reinforcers, and so on. (p. 17)

The present paper will argue that it is this fifth category that now deserves special consideration. The cumulative effects of the learning principles outlined in the fourth area need to be studied in order to understand complex human behavior. Within behavior analysis, the concepts of cumulative-hierarchical learning, basic behavioral repertoires, behavioral cusps, generative instruction, and pivotal responses address this area, but the amount of research is very limited. The importance of cumulative-hierarchical learning and behavioral cusps for assessment and curriculum design will be described.

Staats (1975) described the importance of cumulative-hierarchical learning for understanding human behavior:

The principles of cumulative-hierarchical learning are necessary in indicating that much of human behavior is acquired in learning processes of great duration and complexity. The important aspects of human personality involve extended series where the acquisition of one skill enables the individual to acquire another skill, or an elaboration of the first skill, and this enables the next learning level to be attained. Such concepts and principles must be added to the elementary principles of conditioning to provide a basic framework for the consideration of human behavior. (p. 63).

This relationship between prior learning and later learning is also found in the instructional design literature under the term “learning hierarchies” (Gagne, Briggs, & Wager, 1988). The behaviors that permit later learning are referred to by Staats as “basic behavioral repertoires.” Rosales-Ruiz and Baer (1997) use the term “behavioral cusps” to describe the behaviors or behavioral changes that permit access to new contingencies which further develop an individual’s behavioral repertoire. Infant crawling is described as a cusp because:

The baby suddenly has increased access to the environment and its contingencies. Now the baby can get to toys, family, and other things more easily, or can stumble into obstacles, all of which produce interactions that will further shape the baby’s behavior. (Rosales-Ruiz & Baer, p. 534)

The domain of generative instruction is academic skills, but it is included here because of its close relation to behavioral cusps and cumulative hierarchical learning. According to Johnson and Layng (1992):

Generative instruction...focuses on effective teaching to establish key component skills and their underlying tool elements to fluency. When presented with new environmental requirements, these behaviors can recombine in new ways that correspond to the higher level complex skills shown by experts. (p. 1476)

The Morningside Model of Generative Instruction has been enormously successful in remediating academic skill deficits and accelerating learning (Johnson & Layng, 1992; Johnson & Street, 2004). Part of its success appears to be due to the specific identification of each student's incoming academic repertoire along with effective instructional procedures to fill in the missing pieces. This filling in of the missing pieces makes later learning much easier.

Pivotal responses or areas of functioning are those that when learned result in "widespread collateral changes in numerous other behaviors" (Koegel, Koegel, & Brookman, 2003, p. 342). The concept of pivotal areas of functioning is directly tied to the autism treatment literature, but the concept is conceptually similar to those previously discussed. Koegel, Koegel, and Brookman (2003) describe two pivotal response areas for children diagnosed with autism. One is *motivation*, which specifically refers to increasing social communication responses. The second is *self-initiations*, which refers to increasing self-initiated social interactions. There is some evidence that increasing responding in these two areas results in more widespread improvement in children with autism in less time than traditional applied behavior analysis procedures. More research is certainly needed in this area, but the idea of targeting pivotal areas of functioning may result in more effective and efficient treatments for a variety of behavioral difficulties.

Generative instruction and pivotal responses are narrower concepts because of their association with specific domains of behavior. Behavioral cusps and basic behavioral repertoires and cumulative-hierarchical learning are probably broadest because repertoires that hinder later behavior development or that produce later socially undesirable repertoires are also included. There may be many behaviors that if acquired early in one's life may produce access to contingencies that develop socially undesirable repertoires. In this sense, these types of behaviors would also be behavioral cusps. Rosales-Ruiz and Baer and Staats emphasize the fact that what needs to be understood is the behavioral cusp (which is a teachable behavior, rather than a mental schema or cognitive structure), the learning environment that produced the cusp, and the current environment—that is, the contingencies which make that type of behavior a behavioral cusp. These issues will be illustrated using antisocial behavior as an example because it is one of the few areas in which the etiology and the developmental aspects to the problem behavior are understood.

Many studies have shown that antisocial behavior in children produces many later deleterious effects. Antisocial behavior during the early school years is the best predictor of delinquency and delinquency is the best predictor of adult criminality. Walker, Colvin and Ramsey (1994) found that for students meeting specific cutoffs on 3 easy to record measures of antisocial behavior arrest status could be identified with 80% accuracy 5 years later. They state "It is not exaggerating to say that the path to prison begins very early in a child's career, usually in the elementary grades" (p. 12). Antisocial children are also more likely as adults to have lower paying jobs and be in unhappy marriages (Patterson, Reid, & Dishion, 1992). Of more relevance to the present discussion is *how* antisocial behavior leads to academic failure, peer rejection, and delinquency. Antisocial behavior typically begins in the home (Patterson, Reid, & Dishion, 1992). When the antisocial child enters school, explosive tempers and poor direction-following make the child difficult to teach. Essentially, these children find academic tasks aversive, and their highly developed antisocial repertoires allow them to escape from such tasks. Because they are less likely to follow teacher directions, they spend less time academically engaged than their non-deviant peers (Walker, Shinn, O'Neill, & Ramsey 1987), which leads to academic failure. The peers of antisocial children reject them because of their aversive style of interaction, rather than the rejection causing their antisocial behavior (Patterson, DeBaryshe, & Ramsey, 1989). According to Patterson et al.'s theory, this social rejection by normal peers leads to the antisocial

children developing friendships with other antisocial children. The antisocial peer group contributes to later delinquency and substance abuse (Elliot & Huizinga, 1985 as cited in Patterson et al., 1992). Taken together, these findings explain many of the subsequent deleterious effects of the antisocial repertoire.

The antisocial repertoire is important because it can greatly affect further behavior development. But one must not only understand how the repertoire affects later learning, but also how the repertoire is learned. There is a large area of relevant research here. Patterson et al. (1992) found that parents of antisocial children fail to reinforce prosocial behaviors, are inconsistent in their use of discipline, use harsh discipline, fail to monitor their children's behavior, and frequently "natter" their children. A key variable identified in Patterson and colleagues research is negative reinforcement for the antisocial responses (Patterson, 1982, 2002; Patterson et al., 1992; Snyder & Patterson, 1995). The sequence of interactions starts off with the parent presenting a direction to the child. The child whines, argues, or refuses. The parent then gives in or changes the topic, and the child stops arguing. The giving-in by the parent reinforces the child's arguing, and the child's cessation of arguing reinforces the behavior of giving-in. Patterson and colleagues call this the "reinforcement trap." Another problem that develops is that the child learns that if a low amplitude aversive behavior does not produce reinforcement, a high amplitude behavior is more likely to meet with success (Patterson, 1982; Patterson, et al., 1992).

The effective treatments for children with antisocial behavior also suggest how the repertoire is learned and how it functions in affecting further behavior development. Behavioral treatment of children with antisocial behavior is the most empirically validated form of treatment for these children (Barkley, 1997; Kazdin, 1987; Patterson, 2002). This treatment typically consists of training the parents in the techniques of behavior management (Barkley, 1997; Forehand & McMahon, 1981; Patterson, 1982; Webster-Stratton, Kolpacoff, & Hollinsworth, 1988). Specifically, parents are taught how to reinforce appropriate behavior, in how to give effective commands, and in the use of mild punishment (e.g., time-out). These programs often bring children's compliance within the normal range for children of that age and have lasting effects (Barkley, 1997). A program developed by Engelmann and Colvin (1983) for use in schools with severely noncompliant persons has shown 100% success with the relatively small number of students (at least 26) with which it has been used. The fact that changing the caregiver's reactions to antisocial behavior produces changes in that behavior, suggests that the initial development of antisocial behavior may be the result of caregiver behavior. This conclusion is strengthened by the correlational research described above on the relationship between parental behavior and antisocial behavior (Kendziora & O'Leary, 1993; Patterson et al., 1992). Treatment research not only suggests how the antisocial repertoire is learned, but also how it relates to further behavior development. One longitudinal-experimental study (with random assignment to treatment versus no-treatment) found that a program of parent training and social skills training for two years produced long-lasting treatment effects on measures of school adjustment, police arrests, gang membership, and substance abuse (Tremblay, Masse, Pagani, & Vitaro, 1996). The repeated evaluations over an extended time period allowed the developmental and cumulative effects of the treatment and no-treatment conditions to be detected.

Overall, the longitudinal and experimental research on children with antisocial behavior supports the cumulative nature of learning and the behavioral cusp concept. Previously acquired behaviors provide access to new contingencies that may further develop a socially important or a socially deviant repertoire. By changing how the environment reacts to these behaviors, the cumulative-hierarchical behavior sequence can be altered.

Antisocial behavior is the only behavior domain in which there is some understanding of the cumulative effects of the learning principles. An understanding of the cumulative effects of the learning principles will be critically important for understanding complex human behavior. Hixson (2004) discusses the importance of these concepts and describes research methods for the study of behavioral cusps.

Identifying Behavioral Cusps for Treatment

There are probably a number of universal behavioral cusps - that is, cusps that every or nearly every member of the human race should possess in their behavioral repertoire, such as a reading or imitative repertoire. However, there may be some cusps that are unique to particular environments or to particular individuals. Bosch and Fuqua (2001) proposed that a target behavior would be a behavioral cusp if it met one or more of the following criteria: (1) the behavior results in access to new reinforcers, contingencies, and environments; (2) the behavior is socially valid; (3) generativeness - that behavior allows for the generation of a wide number of behaviors; (4) the behavior competes with inappropriate responses; (5) and/or the behavior affects a large number of people. The Bosch and Fuqua criteria were created as an attempt to identify cusps for the purpose of selecting target behaviors. The use of these criteria might also result in a ranking of behavioral cusps in terms of their importance. Bosch and Fuqua did not, however, describe assessment methods for the identification of behavioral cusps that corresponded to the five criteria. Table 1 lists the types of information that would need to be gathered to identify a possible behavioral cusp for an individual. These questions assume that an assessment of the individual's current behavioral repertoire has been conducted (including reinforcer preferences). In other words, these questions would not be asked if the individual could already perform a particular behavior. The methods used to gather such information could be interviews, but, probably most importantly, behavior observations in natural and analogue conditions. The verification of a cusp would involve experimentally manipulating the behavior and measuring the effect of teaching this behavior on further behavior development. The relationship between teaching a particular behavioral cusp and later learning could be illustrated as in Figure 1.

In the field of child development, development is often described in terms of mental structures, rather than teachable behaviors, and the mental structures are identified because of their increasing complexity. The cognitive structures identified by Piaget, for example, become increasingly sophisticated over time. Behavioral cusps, however, may be idiosyncratic and either complex classes of behavior or very simple behaviors. Rosales-Ruiz and Baer (1997) illustrate this with an example of a child with profound mental retardation who was taught how to manipulate door latches. Teaching this behavior lead to access to new environments that then further developed the child's behavioral repertoire. The teaching of door opening might, for example, allow the child to learn play and verbal skills from other children playing outside (Figure 2). Such a behavior may not need to be targeted for intervention for many children because it is acquired very easily without intervention.

Horne and Lowe (1996) identified a unit of behavior they called the name relation or naming, which permits generalization among echoic, tact, and listener behavior repertoires. The naming repertoire greatly facilitates language acquisition, and therefore is a behavioral cusp. The identification of behaviors or repertoires, such as naming, that result in further important behavior development is important to consider when designing teaching curricula.

Behavioral Cusps and Curriculum Design

The concept of behavioral cusps also has implications for curriculum design. A good curriculum should result in the establishment of behavioral cusps. As previously discussed, a behavioral cusp provides access to new contingencies that further develop the individual's repertoire. In this sense, a curriculum should be hierarchical in nature and result in the establishment of important behaviors. Some in education, however, believe that there are no skill hierarchies (e.g., Heshusius, 1991). For them, breaking skills into subcomponent repertoires is considered "atomistic" and educationally detrimental. However, writing a curriculum should not follow the same process as writing a cookbook. A successful treatment is one that selects procedures and skills based on the child's current repertoire and environment. "A good curriculum should be a highly detailed itinerary describing many, many skills that need to be mastered by a child during the process of growing up" (Harris & Gill-Weiss, 1998, p. 82). The child's program should be organized in a cumulative fashion, by breaking skills into small enough units that the child progresses rapidly from one item to the next.

An example of a hierarchically based curriculum is that of Taylor and McDonough (1996), which is designed for children with autism. The curriculum is divided into three levels: beginning, intermediate, and advanced. In general, each program makes use of the skills acquired in the previous program.

The Beginning Curriculum targets basic listener behavior (attending, sitting, and matching) receptive language, tact, mand and intraverbal training along with some self-help skills. Some skills seem to have no immediate functional significance, like *identify letters/number*, and *counting*, but they are basic to later academic skills. The authors suggest an initial plan that includes attending, receptive training (*following one instruction*) imitation, mand and matching, and they give additional guidelines for the selection of other repertoires. Before starting to teach, careful consideration of the child's existing skills is suggested to guide selection of the target repertoires. For example, echoic behavior should precede intraverbal training, such as answering social questions (e.g., what's your name?, who is your Mom,? etc.). Mand training is recommended to decrease problem behavior. This approach is supported by numerous studies (Carr, & Durand, 1985; Hagopian, Fisher, Sullivan, Acquistio, & LeBlanc, 1998; Sigafos, & Meikle, 1996). The authors also consider whether the skill will lead to the teaching of other skills. Other guidelines are also consistent with behavioral cusps. They say that educators should select behaviors that are important for the child. For example, they should train practical skills like opening a bottle rather than completing a puzzle.

Taylor and McDonough's curriculum is excellent at breaking skills into response components. For example, the *attending* program modestly starts with training eye contact in response to the child's name or to the instruction "look at me." In the intermediate program the criterion for response duration increases (5 sec), the context changes (while playing) and the simple response becomes a response chain (looking and saying "What?"). Finally, in the advanced program, *attending* involves making eye contact during group instruction or during conversation. The concern with the cumulative approach to programming is present in each procedure. For each program Taylor and McDonough suggested prerequisites (some of which are facilitators rather than prerequisites because they are not necessary). For example, the procedure entitled *Predicts Outcome* (p.168) has 5 suggested prerequisites, which each has 3 to 8 prerequisites, which in turn have 3 to 6 prerequisites. The regression goes all the way back to sitting and attending, which means that *Predicting Outcome* requires the combined effects of at least seventy skills!

A good example of the cumulative-hierarchical nature of the program is in the teaching of play skills (this is presented under "social training"). Children with autism are often poor at

playing or maintaining play with their normally developing peers because the activity draws on many repertoires. To maintain a playful interaction (even a simple one, like block building) the child with autism should be able to imitate their peers' behavior, answer various play related questions such as "What do you like to build?" (intraverbal), follow some play related directions "put your block down here..." (receptive), initiate play statements "Let's build a tower" (mand), and make comments during the activity "That's a tall tower" (tact).

While an appreciation of cumulative-hierarchical learning appears in some behavioral programs, research is needed to determine the effects of teaching certain behaviors on later learning. This goes beyond merely doing a task analysis to experimentally manipulating certain behaviors to determine their effects on subsequent learning. The identification of behavioral cusps and pivotal responses that greatly affect later behavior development is particularly important. Research of this type may go a long way in helping us understand child development and behavior development in general.

Conclusion

An important missing piece needs to be filled in the science of behavior—an analysis of the cumulative effects of the learning principles. When what is learned produces further important behavior development, a behavioral cusp has been established. The function altering effects of cusps over environmental variables that will in turn select new behaviors needs to be studied systematically (Hixson, 2004). The behavioral cusp concept also has implications for assessment and curriculum design.

Harris and Gill-Weiss (1998) point out that:

...even the best curriculum has its limits. One of the things a curriculum does not tell us is how long it will take a child to learn a skill. Nor does a good curriculum ensure that a child will, in fact, learn all of the skills we would like him to master. Some children will progress slowly from item to item and may not be able to master every goal. Other children will move rapidly through instructional programs and at times will take leaps that allow them to move quickly from the basic material to the more advanced tasks. A child's progress may also be uneven from area to area. He may do quite well with gross motor skills and have more difficulties with language and socialization."(pp.82-83).

The best approach to address Harris and Gill-Weiss' observation may lie in a better understanding of behavioral cusps and their proper sequencing in accordance with the yet to be discovered knowledge of cumulative-hierarchical learning.

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Table 1.
Information Needed for Identifying Behavioral Cusps

Information Needed	Behavioral Cusp Determination
List the direct reinforcers for that target behavior: Social, automatic, conditioned, unconditioned.	Will the behavior contact new reinforcers?
List and describe the environments that the new target behavior will access.	Will the behavior allow access to new selective environments?
List school personnel or familial beliefs and expectations that may strengthen or weaken the value of the behavior change.	Does the behavior meet the demands of the social community of which the person is a member?
List the audience reactions, such as smiles, laughter, etc.	Is the behavior a reinforcer for the audience?
List the inappropriate behaviors and their severity, including frequency, duration, strength, etc. and the effects on the environment.	Is the behavior interfering with or replacing inappropriate behaviors?
List the behaviors/repertoires subsequently affected.	Is the behavior facilitating subsequent learning by being either a prerequisite or a component of more complex responses?
Approximate number of people physically or emotionally affected over time.	Is the behavior impacting a large number of people?
Give a dollar amount by estimating the cost of physical / property damage, health care, lawsuits, etc over time.	Is the failure to establish this behavior costly?

Behavioral
intervention

Selected Behavior
1

Access to New
Contingencies

Selected Behavior
2

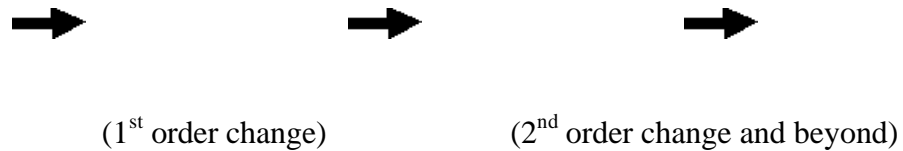


Figure 1. The effects of teaching one behavior on later behavior acquisition.

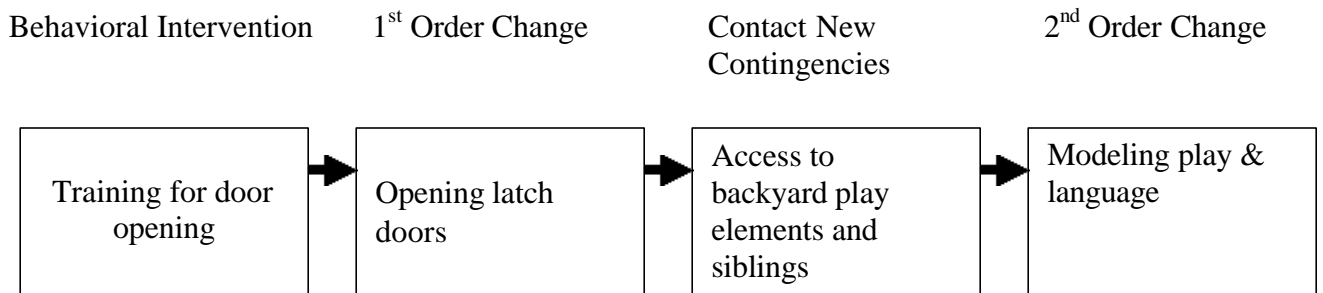


Figure 2. Door opening as a behavioral cusp.

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